

STATEMENT BY N.E. PROMISEL

BEFORE THE SUBCOMMITTEE ON DOMESTIC AND INTERNATIONAL
SCIENTIFIC PLANNING AND ANALYSIS
COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES
NOVEMBER 20, 1975

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

I AM PLEASED TO HAVE THIS OPPORTUNITY TO DESCRIBE OUR ACTIVITIES IN THE FIELD OF ELECTROMETALLURGY AS A PROGRAM WITHIN THE U.S.-U.S.S.R. BILATERAL AGREEMENT ON SCIENCE AND TECHNOLOGY.

FIRST, I WOULD LIKE TO MAKE A FEW GENERAL REMARKS ON THE SUBJECT OF MATERIALS SCIENCE AND ENGINEERING AND INTERNATIONAL COOPERATION, WITH PARTICULAR REFERENCE TO THE U.S.S.R.; THEN DESCRIBE THE AREA OF ELECTROMETALLURGY IN TERMS OF OUR SPECIFIC PROGRAM, AND ITS SIGNIFICANCE AND POTENTIAL CONTRIBUTION TO U.S. TECHNOLOGY; AND FINALLY, NOTE THE STATUS OF OUR PROGRAM AND OUR EXPECTATIONS, AS WELL AS COMMENT ON OUR EXPERIENCE IN WORKING WITH THE SOVIETS.

THE FIELD OF MATERIALS SCIENCE AND ENGINEERING IS PERHAPS THE MOST PERVASIVE AND EXTENSIVE OF ALL FIELDS OF SCIENCE AND ENGINEERING. IT IS MULTI-DISCIPLINARY, EMBRACING AS IT DOES ABOUT A HALF MILLION SCIENTISTS AND ENGINEERS IN THE U.S. IN ITS COMPONENT DISCIPLINES OF METALLURGY, CHEMISTRY, PHYSICS AND MECHANICAL ENGINEERING. MATERIALS ARE ONE OF THE BASIC RESOURCES OF MANKIND SINCE THE BEGINNING OF HISTORY. THEIR INTIMATE RELATION

Electro metallurgy

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AND IMPORTANCE TO CURRENT NATIONAL PROBLEMS OF ENERGY, MINERAL
RESOURCES, ENVIRONMENTAL CONTROL, INDUSTRIAL HEALTH AND
PRODUCTIVITY, HUMAN WELL-BEING AND MAN'S NEEDS IN GENERAL HAVE
BEEN CLEARLY DEMONSTRATED. THE CONTRIBUTIONS OF THIS FIELD IN
THE LAST FEW DECADES TO OUR ADVANCED TECHNOLOGIES SUCH AS IN
ELECTRONICS, AEROSPACE AND DEFENSE SYSTEMS HAVE BEEN MOST
IMPRESSIVE.

BECAUSE THE MATERIALS PROBLEMS AND OPPORTUNITIES THAT CONFRONT
US ARE EQUALLY IMPRESSIVE, THE MATERIALS COMMUNITY HAS NATURALLY
BEEN VERY MUCH INTERESTED IN TECHNICAL HAPPENINGS THROUGHOUT THE
REST OF THE WORLD. THE GENERAL FEELING OF PERHAPS A DECADE AGO
THAT THE U.S. HAD AN UNASSAILABLE LEAD OVER THE REST OF THE WORLD
NO LONGER PREVAILS. AS DR. HARVEY BROOKS, DEAN OF HARVARD
UNIVERSITY'S DIVISION OF ENGINEERING AND APPLIED PHYSICS, HAS
STATED, THE CONCEPT OF NATIONAL SUPERIORITY IN SCIENCE AND
TECHNOLOGY IS OBSOLESCENT; INDEED, IT IS INCREASINGLY DIFFICULT
TO TELL WHO IS "AHEAD" AND WHO IS "BEHIND." MATERIALS SCIENCE
AND ENGINEERING IS DEFINITELY AN AREA OF INTERNATIONAL ACTIVITY.
OUR COMMUNICATIONS LINKAGES IN THE FIELD OF MATERIALS WITH SOME
FOREIGN COUNTRIES HAVE BEEN EXCELLENT AND NUMEROUS, AS IN THE
CASE OF THE UNITED KINGDOM, BUT LESS SO WITH REGARD TO THE U.S.S.R.
YET, EVEN FROM THE LIMITED INTERACTIONS WITH THE U.S.S.R. TO DATE,
WE HAVE BECOME FAMILIAR WITH ITS MATERIALS RESEARCH AND DEVELOPMENT,
FOR EXAMPLE IN METALLURGY, THAT ARE OF GREAT INTEREST TO US. OUR
INDUSTRY HAS RECOGNIZED THIS, AS EVIDENCED BY THE NUMBER OF LICENSES,
SOME IN METALLURGY, PURCHASED FROM THE U.S.S.R. BY SOME OF OUR
LEADING COMPANIES. ALSO, THE ANNUAL NUMBER OF U.S. PATENTS

GRANTED THE U.S.S.R. HAS INCREASED FROM 66 IN 1966 TO 492 IN 1974!

IT WAS AGAINST THIS BACKGROUND THAT A NUMBER OF U.S. AGENCIES AND INDUSTRY AND UNIVERSITY REPRESENTATIVES RESPONDED ENTHUSIASTICALLY TO THE POSSIBILITY OF A COOPERATIVE ACTIVITY IN THE FIELD OF ELECTROMETALLURGY, IN WHICH EXTENSIVE SOVIET ACTIVITY AND PROGRESS WAS KNOWN. ELECTROMETALLURGY IS A RATHER BROAD AND AMBIGUOUS TERM. FOR OUR PRESENT PURPOSES, ITS NATURE WILL BECOME CLEAR THROUGH THE DESCRIPTION OF OUR PROGRAM BELOW. IN CONSIDERING SPECIFIC SUBJECTS FOR A COOPERATIVE PROGRAM, WE HAVE USED THREE BASIC CRITERIA: (1) THE ADVANCED TECHNOLOGY IF NOT ACTUAL SUPERIORITY OF THE SOVIETS IN SPECIFIC AREAS; (2) THE PRACTICAL IMPORTANCE AND SIGNIFICANCE TO THE U.S. OF THE POTENTIAL RESULTS; AND (3) THE INTEREST AND AVAILABILITY OF CAPABLE U.S. INVESTIGATORS TO WORK ON THESE TOPICS. THE TOPICS FINALLY AGREED UPON, AND OUR REASONS FOR SELECTING THEM, ARE BRIEFLY AS FOLLOWS:

(1) ELECTROSLAG REMELTING - A PROCESS OF MELTING AND REFINING STEEL THAT DEPENDS ON A LAYER OF MOLTEN SLAG OR CHEMICALS INSTEAD OF VACUUM TO PROTECT AGAINST ATMOSPHERIC DAMAGE AND TO DO THE REFINING. THE PROCESS WAS DEVELOPED TO ITS PRESENT ADVANCED STAGE OF TECHNOLOGY AND USAGE BY THE SOVIETS, WHO ARE NOW THE WORLD'S LEADING DESIGNERS AND USERS OF THIS PROCESS. THE PROCESS IS PARTICULARLY USEFUL FOR SPECIALTY, HIGH QUALITY ALLOYS SUCH AS TOOL STEELS, HIGH

TEMPERATURE ALLOYS SUCH AS ARE NEEDED IN AIRCRAFT GAS TURBINES, AND CORROSION AND HEAT RESISTING STEELS. IT HAS WIDE UTILITY, HIGH EFFICIENCY, AVOIDS PROBLEMS OF COMPETITIVE PROCESSES, AND PRODUCES HIGH PURITY, UNIFORM, SOUND MATERIAL CONDUCTIVE TO IMPROVED TOUGHNESS AT HIGH STRENGTH LEVELS.

FOR EXAMPLE, IT IS CLAIMED TO BE CAPABLE OF PRODUCING LARGE CASTINGS SUITABLE FOR HEAVY POWER EQUIPMENT OF QUALITY EQUAL TO THE MORE EXPENSIVE AND AWKWARD FORGED AND WELDED COMPONENTS. THE SCOPE OF OUR PROJECT INVOLVES BASIC SCIENTIFIC STUDIES AND THE EXCHANGE OF DATA, METHODOLOGY, MATERIAL AND SAMPLES.

(2) PLASMA ARC MELTING - A PROCESS USING IONIZED GAS "PLASMA" TO PRODUCE EXTREMELY HIGH TEMPERATURES, A VERY CLEAN, HIGH ENERGY SOURCE USEFUL METALLURGICALLY FOR MANY PURPOSES SUCH AS MELTING, WELDING, CUTTING AND COATING. FOR THE MELTING PROCESS, IT PROVIDES A VERY VERSATILE TOOL FOR MAKING VERY HIGH QUALITY, DUCTILE STEEL AND NON-FERROUS ALLOYS, WITH MINIMUM LOSS OF HEAT ENERGY, USEFUL, FOR EXAMPLE, IN CRYOGENIC APPLICATIONS SUCH AS TRANSPORTING LIQUIFIED NATURAL GAS. USING THIS TECHNIQUE, THE SOVIETS CLAIM THEY HAVE PRODUCED HIGH NITROGEN STEELS SHOWING AN UNUSUAL COMBINATION OF PROPERTIES, FABRICABILITY, WELDABILITY, CORROSION

AND WEAR RESISTANCE. ONE CAN EASILY POSTULATE EXTENSIVE USES FOR SUCH MATERIALS. THE STATE OF TECHNOLOGY AND EQUIPMENT IN THE U.S. DOES NOT PERMIT US TO MAKE THESE HIGH NITROGEN ALLOYS (EXCEPT ON A LABORATORY SCALE) NOR WOULD IT BE WARRANTED TO EXPEND MILLIONS OF DOLLARS TO DEVELOP KNOW-HOW AND EQUIPMENT WITHOUT HAVING A BETTER EVALUATION OF THIS TYPE OF MATERIAL. OUR PROGRAM WITH THE SOVIETS IS THEREFORE OF TWO PARTS:

(1) BASIC STUDIES OF HIGH TEMPERATURE NITROGEN REACTIONS, AND (2) CRITICAL EXAMINATION OF A PILOT-PLANT SIZE INGOT OF HIGH-NITROGEN STEEL.

THE SOVIETS ARE CASTING THIS INGOT, WEIGHING ALMOST HALF A TON, AND WILL FURNISH IT TO US WITHOUT COST, IN RETURN FOR THE RESULTS OF OUR CRITICAL EVALUATION.

(3) ELECTRON BEAM EVAPORATED COATINGS. THE USE OF ELECTRON BEAMS AS A SOURCE OF CLEAN, HIGH TEMPERATURES THAT CAN BE CLOSELY CONTROLLED HAS LED TO THEIR EXTENSIVE USE IN CRITICAL MELTING AND WELDING SITUATIONS, BOTH HERE AND ABROAD. IN THE U.S.S.R., THERE HAS BEEN A STRONG, CONCENTRATED, HIGH QUALITY EFFORT TO USE THIS SOURCE OF HEAT FOR EVAPORATING HARD, HIGH-MELTING MATERIALS AND CONDENSING THEM AS COATINGS. OF PARTICULAR INTEREST IS THE PRODUCTION OF COATINGS ON CUTTING TOOLS TO INCREASE THEIR EFFICIENCY AND LIFE. IN THE U.S., THE CURRENT ESTIMATED COST OF ALL OPERATIONS INVOLVING MATERIALS REMOVAL (INCLUDING ROCK TUNNELLING

AND BORING, AND CUTTING TOOLS AND HOLDERS) IS ROUGHLY BETWEEN \$70 AND \$85 BILLION, ANNUALLY. ADD TO THIS THE AREA OF NUMERICALLY CONTROLLED MACHINING AND IT IS EVIDENT THAT EVEN AS LOW AS A 1% OR 2% IMPROVEMENT IN TOOL LIFE COULD RESULT IN ANNUAL SAVINGS OF HUNDREDS OF MILLIONS OF DOLLARS. ACTUALLY, ANTICIPATED IMPROVEMENTS IN TOOL LIFE FAR EXCEED 1% OR 2%. FOR THIS REASON (AND OTHERS) AND BECAUSE OF THE INTENSIVE, COMMENDABLE WORK IN U.S.S.R., THIS SUBJECT WAS SELECTED FOR COOPERATION. THE PROJECT CALLS FOR COORDINATED BASIC RESEARCH ON THE NATURE AND BEHAVIOR OF THE COATINGS, THE EXCHANGE OF MATERIALS, AND STANDARDIZED TESTS AND EVALUATION OF THE COATINGS ON CUTTING TOOLS.

(4) WELDING AND JOINING. JOINING MATERIALS IS ONE OF THE MOST PREVALENT, CRITICAL AND IMPORTANT OF ALL FABRICATING PROCESSES, IN APPLICATIONS, FOR EXAMPLE, FROM TINY ELECTRONIC PARTS TO HUGE SHIPS. IN SPITE OF IMPRESSIVE ADVANCES IN THIS FIELD OVER THE YEARS, MAJOR PROBLEMS STILL EXIST, FOR EXAMPLE IN WELDING PIPE LINES EXPOSED TO LOW TEMPERATURES, IN MAKING HEAVY PRESSURE VESSELS, IN JOINING DISSIMILAR MATERIALS. THE U.S.S.R. HAS PLACED HEAVY EMPHASIS ON THIS FIELD, PROBABLY MORE SO THAN THE U.S. HAS, AND THE PATON INSTITUTE IN KIEV IS KNOWN INTERNATIONALLY FOR ITS CONTRIBUTIONS, ONE OF WHICH IS ELECTROSLAG WELDING. SOLID STATE JOINING -- WHICH AVOIDS THE MELTING IN A

WELDING OPERATION -- IS MORE ADVANCED IN U.S.S.R.

PRODUCTION THAN ANYWHERE ELSE IN THE WORLD, INsofar AS WE CAN ASCERTAIN. IT SEEMED DESIRABLE, THEREFORE, TO ASSESS THE SOVIET STATE OF THE ART, COMPARED TO OUR OWN, THROUGH EXCHANGE OF WELDING MATERIALS AND SAMPLES OF WELDING TECHNIQUES. IN ADDITION, THERE WILL BE BASIC STUDIES AND INVESTIGATION OF CRYOGENIC MATERIALS AND WELDED JOINTS. IN SOLID STATE JOINING, STATE OF THE ART REVIEWS WILL BE EXCHANGED AND DEVELOPMENT OF IMPROVED TECHNIQUES INITIATED. OF PARTICULAR INTEREST IN THESE SOLID STATE STUDIES ARE COMPOSITE DISSIMILAR MATERIALS, ONE OF THE MOST EXCITING MATERIAL DEVELOPMENTS OF THE LAST TWO DECADES.

I HAVE NOW DESCRIBED, AS SIMPLY AS I COULD, THE TECHNICAL HIGHLIGHTS OF OUR PROGRAM, THE IMPORTANCE AND SIGNIFICANCE OF THE SELECTED SUBJECTS TO THE U.S., AND, IN ESSENCE, THE REASONS FOR THIS SELECTION. I DO NOT MEAN TO IMPLY THAT WE UNILATERALLY DICTATED THIS PROGRAM, OR THAT THE SOVIET SIDE WAS COMPLETELY PHILANTHROPIC IN ITS AGREEMENT. THERE ARE "QUID PRO QUOS" ON BOTH SIDES, MAKING THIS PROGRAM A TWO-WAY STREET WITH RESPECT TO BOTH EXCHANGE OF INFORMATION AND MATERIAL, AS WELL AS JOINT RESEARCH AND DEVELOPMENT EFFORTS. IT WILL BE NOTED THAT THE OVER-ALL PROGRAM COVERS THE SPECTRUM FROM SCIENCE AND RESEARCH THROUGH ENGINEERING APPLICATION.

THE STATUS OF THE ABOVE PROJECTS IS LIKEWISE EQUITABLE FROM BOTH SIDES. IN THE TWO YEARS THAT HAVE ELAPSED SINCE BOTH SIDES

FIRST MET TO DISCUSS IN BROAD TERMS, THE POSSIBILITY AND NATURE OF A COOPERATIVE EFFORT, OUR OVER-ALL PROGRAM HAS BEEN DEFINED IN WRITING, DOWN TO THE FINEST DETAIL. INDEED, MANY OF THE AGREED-UPON STUDIES HAVE ALREADY BEEN INITIATED ON BOTH SIDES; TECHNICAL INFORMATION HAS BEEN EXCHANGED; THE U.S. RECEIVED SAMPLES OF TOOL COATINGS MONTHS AGO AND WILL RECIPROCATATE DURING A SOVIET VISIT HERE IN DECEMBER; THE FREE HALF TON HIGH-NITROGEN INGOT IS REPORTED TO BE READY FOR SHIPMENT TO THE U.S., EXCHANGE MATERIALS ARE BEING ACCUMULATED FROM INDUSTRY AND WE EXPECT TO SHIP OUR FIRST BATCH OF WELDING MATERIALS WITHIN THE NEXT FEW WEEKS; AND, TEAMS OF EXPERTS ON EACH SUBJECT HAVE BEEN FORMED AND ARE EXCHANGING VISITS. WE EXPECT TO FINISH SOME PROJECTS DURING 1976 AND MOST OF THE REMAINDER BY SPRING 1977.

AND NOW FOR SOME CONCLUDING REMARKS AND OBSERVATIONS. THE PROGRAM ON WHICH WE HAVE EMBARKED WITH THE SOVIETS APPEARS MOST PROMISING TO US, IN TERMS OF IMPORTANT CONTRIBUTIONS TO OUR MATERIALS TECHNOLOGY, BASIC UNDERSTANDING, INDUSTRIAL APPLICATIONS, PROBLEM-SOLVING AND FUTURE DESIGN OF EQUIPMENT AND PROCESSING. ALTHOUGH WE ANTICIPATE A HIGH DEGREE OF SUCCESS IN ACHIEVING OUR OBJECTIVES, WE OBVIOUSLY CANNOT, AT THIS STAGE, GIVE BROAD "GUARANTEES." HOWEVER, REGARDLESS OF SPECIFIC TECHNICAL ACHIEVEMENTS, THE OPPORTUNITY FOR US TO DISCUSS THE SELECTED AREAS WITH KNOWLEDGEABLE COUNTERPARTS HAS BEEN VERY WORTHWHILE. WE HAVE BEEN ABLE TO IDENTIFY PEOPLE AND PLACES OF EXCELLENCE IN THE U.S.S.R. AND TO ACHIEVE VALUABLE PERSONAL RAPPORT, UNDERSTANDING AND FAMILIARITY. THE JOINT RESEARCH STUDIES ARE EXPECTED TO PROVIDE US WITH DESIRED KNOWLEDGE AT LESS COST TO THE U.S. IN MONEY AND

MANPOWER THAN IF WE WORKED ALONE. WE HAVE PLANNED SEVERAL SMALL SEMINARS, WITH EVENTUALLY A MAJOR SYMPOSIUM SO THAT THE INFORMATION GAINED WILL BE DISSEMINATED TO THE WIDEST U.S. AUDIENCE. THIS AUDIENCE NOW INVOLVES PARTICIPANTS FROM U.S. INDUSTRY, GOVERNMENT AND ACADEMIA. FURTHERMORE, WE HAVE BEEN INVITED TO SEND OUR RESEARCH PERSONNEL TO SOVIET LABORATORIES FOR EXTENDED PERIODS, E.G., 1 TO 3 MONTHS, IN RETURN FOR SOVIET SCIENTISTS AT U.S. LABORATORIES.

WE HAVE ENCOUNTERED NO SIGNIFICANT PROBLEMS IN OUR NEGOTIATIONS WITH THE U.S.S.R. TO DATE. DIFFERENCES HAVE BEEN RECONCILED BY FRIENDLY DISCUSSION AND COOPERATION ON BOTH SIDES. EACH SIDE HAS MANAGED TO INCLUDE THOSE FEATURES OF THE PROGRAM IT CONSIDERED IMPORTANT TO ITSELF. BOTH SIDES HAVE ALSO BEEN VERY COOPERATIVE IN ARRANGING DESIRED VISITS TO LABORATORIES AND TO SELECTED PERSONNEL; WE ARE SATISFIED IN THIS REGARD. PERHAPS AS THE BEST INDICATOR OF PERCEIVED BENEFITS, OUR TEAM ON THE WHOLE CONTINUES TO RETAIN HIGH INTEREST AND ANTICIPATES FRUITFUL RESULTS.

THANK YOU FOR YOUR ATTENTION.